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Soil Analysis

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North Shore

Upper Lake Ranger District, Mendocino National Forest
Lake County, California

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Soils Analysis

Methodology

A unit selection strategy was used to determine which units should have site-specific data collected. Selection was based on soil sensitivity and type of management activities planned. Soils with high compaction or erosion hazard ratings and areas with evidence of previous disturbance received a high priority for field review. Units proposed for ground-based commercial harvest, which have the highest probability of impacting the soil resource, were also granted a high priority for field review. Field investigation was done by making two to three traverses across each unit. Site and soil data was collected from plots along these traverses. The following types of existing site disturbances were identified in the field during the traverses: skid trails, old roads, and old landings. The level of soil disturbance was estimated for each soil disturbance type. Soil data noted in the field included rock outcrops, surface rock, and a range of soil depths.

Analysis Indicators

The effects of individual management activities on the soil resource (soil productivity and soil ecosystem functionality) is guided using the Forest Plan's Standards and Guidelines and FSM 2500, Chapter 2550, Supplement 2500-2012-1.

For the purposes of this report and analysis, it is assumed that the activities proposed in the North Shore Project will cause similar disturbance as results from soil disturbance monitoring on the Klamath National Forest (USDA 2012b). The Klamath National Forest soils disturbance monitoring report was developed using the National Forest Soil Disturbance Monitoring Protocol (USDA 2009).

Three indicators were chosen that best address relevant issues in the project and measure compliance: soil stability, soil organic matter, and soil structure.

Soil quality standards measured by the analysis indicators are to be met on at least 85% of the acres within proposed treatment units. The threshold of concern for not meeting Forest Plan direction relating to soil productivity would be if 15% or more of a unit is not meeting desired conditions for the three soils analysis indicators combined.

The unit of measure for each indictor is the number of acres not meeting desired conditions. Table 1 describes what constitutes desired conditions for each of the indicators.

Table 1. Indicator Condition Assessment.

Soil Function	Indicators	Indicator Conditions		
		Good	**Fair**	**Poor**
		Meets Desired Condition	**Partially Meets Desired Condition**	**Does Not Meet Desired Condition**
Support for Plant Growth and Soil Hydrologic Function	Soil Stability	An adequate level of soil cover is present and signs of erosion are not visible or very limited in degree and extent. Any existing erosion control measures are effective. Generally, soil cover level is 50% or greater and is well distributed for soil types capable of supporting this level.	For minor portions of the area, soil cover is lacking and/or existing erosion control measures are ineffective. There are signs of erosion such as pedestals, sheet, rill, and/or gully erosion visible.	Major portions of the area lack soil cover and/or lack effective erosion control measures. Signs of erosion such as pedestals, sheet, rill, and/or gully erosion are common.
Support for Plant Growth	Soil Organic Matter	The thickness and color of the upper soil layer is within the normal range of characteristics for the site and is distributed normally across the area. Localized areas of displacement may have occurred but it will not affect the productivity for the desired plant species.	For minor portions of the area, the upper soil layer has been displaced or removed to a depth and area large enough to affect productivity for the desired plant species. Generally, an area will be considered displaced if more than one-half of the upper soil layer or 4 inches (whichever is less) is removed from a contiguous area larger than 100 square foot	Major portions of the area have had the upper soil layer displaced or removed to a depth and area large enough to affect productivity for the desired plant species.
Soil Hydrologic Function	Soil Structure	Visually, soil structure and macro-porosity (defined here as pores 1mm or larger) are relatively unchanged from natural condition for nearly all the area. Signs of erosion or overland flow are absent or very limited in degree and extent. Infiltration and permeability capacity of the soil is sufficient for the local climate.	For minor portions of the area: soil structure and macro-porosity are changed; or platy structure and/or increased density evident; or overland flow and signs of erosion are visible. Infiltration and permeability capacity is insufficient in localized portions of the area.	Major portions of the area have reduced infiltration and permeability capacity indicated by soil structure and macro-porosity changes; or platy structure and/or increased density; or signs of overland flow and erosion.

Measures

Compaction Risk Rating

The compaction risk rating helps determine general susceptibility to loss of soil productivity from equipment operation. It considers the risk of compaction occurring and if compaction will result in productivity loss. It is based on the soil texture and rock content (Table 2). It presumes the soil is at field capacity or at a moisture level where the soil is most susceptible to a density increase under heavy equipment operation (USDA 2006).

Table 2. Compaction Risk Rating.

Coarse Fragment Content by Volume	Soil Texture	Hazard Rating
Fragmental (greater than 70 percent)	Any Texture	Low
Skeletal (35 to 70 percent)	Sandy	Low
Skeletal (35 to 70 percent)	Loamy	Moderate
Skeletal (35 to 70 percent)	Clayey	High
Less than 35 percent	Sandy	Low
Less than 35 percent	Loamy	Moderate
Less than 35 percent	Silty	High
Less than 35 percent	Clayey	High

Erosion Hazard Rating

The Region 5 Soil Erosion Hazard Rating System was used to rate the risk of soil erosion for all soils in the project area. This system uses various physical soil properties along with climate and site-specific conditions to rate soils for hazard of sheet and rill erosion. This system is used to determine the amount of post-activity surface cover necessary to keep erosion hazard risk low or moderate (USDA 1990). In addition to the erosion hazard risk rating system, the project design features and Best Management Practices have been identified for levels of total soil cover that should be maintained at the stand level to reduce the potential of soil erosion (see Hydrology Report, Appendix B- Project Design Features).

Existing Conditions

Soils in the project area have mainly developed from marine sediments. The mountain landscape of the area led to soils forming on the following landforms ridges, structural benches, and mountain side slopes. Soils in this project area are range from moderately deep (24 to 40 inches) gravelly to very gravelly loams and silty loams. Found in pockets throughout the project area are soils developed from serpentinized peridotite. These soils are moderately deep, to deep gravelly, to extremely gravelly loams and silty loams with moderate soil productivity.

Field sampling of North Shore Project units proposed to be treated using ground based systems was done July 2019. The average slope within these units ranges from 9 to 35 percent with an overall average of 25 percent. As this is a burned area, the amount of overall existing soil cover is expected to be low. However, upon field surveys, existing total soil cover ranges from 5 to 100 percent and averages 76 percent.

Using the National Forest Soil Disturbance Monitoring Protocol (USDA 2009), about 20 percent of the surveyed units were rated as disturbance class 0 (undisturbed), 40 percent were rated as class 1, 40 percent were rated as class 2, and 0 percent rated as class 3 (highest disturbance rating). The types of disturbance that were found include topsoil displacement on old skid trails, rutting on old skid trails, and compaction on old skid trails and landings. Desired conditions for soil stability were met across the entire project area because soil cover levels were high, and no excessive signs of erosion were found. Desired conditions for soil organic matter and soil structure were met on an average of 94 percent of the project area.

Calculated from 230 soil plots, about 6 percent of the surveyed treatment area (excluding system roads) has been disturbed from past activities. In the treatment area, 96 percent of the disturbance is on existing skid trails, 3 percent on existing landings, and 1 percent on existing waterbars. Desired conditions for soil stability were met across all treatment areas.. Full field investigations and soil disturbance transects were conducted in 6 of 12 units proposed for ground-based harvest. Units 2, 7, 9, 10, 12, and 13 were not transected. Visual transects were conducted on 1 of 2 units proposed for skyline harvest.

Alternatives

No Action

Without any actions there will be no direct effect on soils, as soil disturbing activities would not take place. Soil cover for erosion protection would not change in the project area. Soil organic matter would continue to accumulate faster than decomposition rates. There would be no additional benefit to soil fertility since no action would be taken. Soil structure conditions would remain the same in the short-term, with very slow long-term natural recovery of old skid trails and landings.

Indirect effects of no action would cause the increased accumulation of organic matter in terms of surface and ladder fuels, with a corresponding continual increase in fire hazard. Years of fire suppression and past management activities have led to overly dense stands, which have increased the risk of large-scale high severity wildfire. As fire intensity increases, the potential for soil organic matter destruction, nitrogen volatilization, microbial mortality, structure and porosity destruction, and inducement of water-repellency are greatly elevated. This can severely damage soils and cause long-term declines in soil productivity and hydrologic function. In extreme cases, soils cannot be revegetated without management intervention.

Past actions including timber harvest and thinning are evident on the landscape in the project area and are reflected in the discussion of the affected environment. Since there are no other reasonable future actions occurring in the soils analysis area there would be no cumulative effect on soils.

Effects by Action

Ground-based tractor logging

Ground based tractor logging with associated landings would result in reduced levels of soil cover on skid trails and landings but project design features would reduce the potential for soil erosion. Project design features require minimum levels of soil cover depending on slope steepness and require cover levels to be met before the rainy season. The project design feature that prescribes placement of waterbars on skid trails and erosion control on landings would be effective in controlling runoff and preventing off-site sedimentation. Additionally, project design features limit the slope steepness for operating ground-based logging equipment to slopes less than 35 percent which would reduce the potential for soil erosion. The amount of soil cover in non-skid trail areas would act as sediment filters and prevent skid trail derived sediment from reaching a drainage channel. Best management practice (BMP) monitoring of skid trails and landings show that water bars and erosion control measures are effective in controlling erosion and preventing sediment from reaching a stream course (USDA 2011b). Monitoring data from previous projects with ground-based tractor logging units indicates that 95 percent of the units would meet desired conditions for soil stability following project implementation. There were not any conditions found in the project area that would indicate a deviation from the monitoring data.

A combination of increased compaction, reduced soil cover, and soil displacement would lead to a loss of nutrients on the skid trails and landings where ground based tractor logging takes place.

Project design features including placement of waterbars, slope restrictions on ground-based equipment, and soil cover guidelines were designed to minimize the loss of soil organic matter from the unit. Additionally, project design features to protect course woody debris would ensure these features would provide soil nutrients into the future. Monitoring from previous projects with ground-based tractor logging units indicates that 90 percent of the unit would meet desired conditions for soil organic matter following project implementation. There were not any conditions found in the project area that would indicate a deviation from the monitoring data.

Ground-based equipment would cause soil compaction on landings and primary skid trails, but with proper layout, the level of disturbance can be kept below levels that would impact stand productivity. Placing a high priority on reusing existing skid trails would help to ensure that the area occupied by skid trails can be minimized. Soil compaction leading to poor soil strength and structure would occur on the heavily used portions of primary skid trails and landings. On skid trails where machinery makes one or two passes, compaction increases only slightly; rooting environment and infiltration are not negatively affected. Project design features put limitations on the use of ground based equipment during wet weather and saturated soil conditions reducing the amount of compaction on skid trails. Monitoring from previous projects with ground-based tractor logging units indicates that 95 percent of the units would meet desired conditions for soil structure following completion of treatment activities. There were not any conditions found in the project area that would indicate a deviation from the monitoring data. The effects of soil compaction on conifer production over a 20 year study (Busse, Matt D.; Fiddler, Gary O.; Shestak, Carol J 2017) show that the soil was still affected after 20 years but it did not significantly affect conifer root production. Disturbance monitoring in relation to compaction was performed on the Klamath and is summarized in the "Effects of Ground-Based harvesting on Soil Disturbance, Bulk Density and Total Porosity on the Klamath National Forest" (Laurent 2007). Ground based logging disturbance is expected to produce similar conditions on the Mendocino National Forest as the Klamath National forest.

Machine piling could be used to treat activity generated fuels in ground based tractor logged units. Machine piling would not impact surface and soil organic matter because fine surface fuels and topsoil would not be piled. Reducing activity generated surface fuel loading with machine piling would result in lower temperatures and shorter residence time of prescribed fire which would benefit soil micro-organisms and tree roots. The disturbance to the soil from machine piling is not expected to disturb any additional acres than the ground based logging activities.

Skyline logging

Skyline cable logging would result in small amounts of soil displacement in the yarding corridors from the tail end of the log dragging on the soil surface. This log dragging usually does not occur over the entire corridor length. The cable corridor can vary from 6 to 8 feet wide and would have an area in the center of the corridor that is down cut 9 to 12 inches deep (based upon past field observations and best management practice monitoring). When properly water barred, no significant erosion would leave the harvest units. Soil compaction and reduced soil porosity would be minimal to none. Monitoring of previous projects with cable logging units indicates that desired conditions for soil stability, soil organic matter, and soil structure are met following completion of treatment activities. There were not any conditions found in the project area that would indicate a deviation from the monitoring data.

Manual Thinning

Manual thinning would not add to the existing disturbance to soils indicators nor would it add to the disturbance caused by other proposed treatment activities.

Mastication

Machine mastication should maintain the high levels of existing cover by cutting the existing live and dead standing material into smaller pieces and letting it fall to the soil surface. Machine mastication would have a slight impact to soil organic matter because fine surface fuels would be increased with minimal disturbance to the topsoil. Machine traveling over masticated materials reduces the potential for soil compaction. Slight increases in compaction would occur in travel access corridors around the unit. Monitoring of previous projects with mastication units indicates that desired conditions for soil structure and soil organic matter are met across 95 percent of units and soil structure desired conditions are met across 100 percent of units following completion of treatment activities. There were not any conditions found in the project area that would indicate a deviation from the monitoring data. The acres not meeting desired condition in table 3 are an overestimation of acres not meeting desired conditions. This is due to the fact that analysis was completed for the entire project area to simplify the process and provide for a "worst case scenario" evaluation. Acres for mastication will be far less than what was analyzed.

Prescribed Fire

Prescribed fire and pile burning can alter microbial communities in a forest stand by increasing the temperature of the post burn soil surface or by changing the availability of organic substrates. Soil heating during the burn results in a substantial short-term loss of microbial biomass or a shift in community structure. These changes, and their duration are the result of the interactions of fuel load, fuel moisture content, weather conditions, landscape position, light-up sequence, and resulting fire behavior and resident time combined with heat transfer variability within the soil profile (Busse et al. 2005). The low and moderate burn severities that are prescribed for this project would have short term impacts to soil organic matter and microbial communities. These impacts would not affect the long term productivity of the project area. If burn severities are kept to low and moderate levels, soil organic matter desired conditions are expected to be met for prescribed fire and pile burning treatments. Recent soil cover monitoring of prescribed fire on the Forest for the best management practice monitoring report has shown that post-burn soil cover exceeds levels prescribed in standard and guides (USDA 2011). If soil cover guidelines are followed, soil stability desired conditions are expected to be met for prescribed fire treatments.

Temporary roads on existing roadbeds and landings

Existing roadbeds that are proposed for use as temporary roads would be cleared and graded; this would reduce soil cover levels during project implementation. Erosion from temporary roads would be mitigated by grading to out-slope and covering with slash, if needed, after the harvest season (prior to the first winter after use and prior to additional winters if used for more than one harvest season). Temporary roads would be hydrologically stabilized and closed after project completion, mitigating long-term erosion in the project area. With erosion control features in place before the start of the wet season, soil stability desired conditions are expected to be met for 95 percent of temporary roads.

Temporary roads on existing roadbeds may have the upper soil layer displaced or removed when the roadbed is cleared, to allow log truck and equipment access. Additionally, temporary roads on existing roads beds would have increased soil strength and cause reductions in infiltration and permeability. Research has shown that forest roads disrupt the physical environment through increased compaction and reduced porosity (Trombulak and Frissell 2000). The loss of soil organic matter and increase in soil strength would limit the growth of trees growing next to temporary roads, because these roads occupy only a minor part of the project area, productivity throughout the stand would not be affected. While soil compaction would reduce infiltration and permeability, slash cover would reduce overland flow and prevent soil erosion. Temporary roads and landings are not expected to meet desired conditions for soil organic matter and soil structure. Depending on the level of disturbance subsoiling some temporary roads would reduce the recovery time needed to promote desired conditions. Table 3 shows the estimated number of acres not meeting desired conditions based on previous KNF forest monitoring data, this number includes the acreage not meeting desired conditions due to temporary roads and landings, and it is below the 15 percent threshold listed in the forest plan.

Monitoring from previous projects on the KNF has shown an increase in compaction, reduction in soil cover, and soil displacement leading to a loss of nutrients and reduced infiltration on landings and temporary roads. Landings and temporary roads, therefore, do not meet desired conditions for soil organic matter and soil structure because the majority of these areas have the upper soil layer displaced or compacted enough to affect hydrologic function and productivity for the desired plant species. It is expected to be the same in the North Shore Project area.

The potential negative effects of landings and temporary roads are reduced through project design features that prevent damage from occurring, reduce the risk of further damage, and restore areas after damage has occurred. Impacts are prevented by limiting the extent of landings and main skid trails to 15 percent of units and ground-based equipment operation is restricted during periods of wet weather. The risk of future negative impacts is reduced by blocking access and hydrologically stabilizing landings and temporary roads. Finally, restoration of soil functions on landings and temporary roads would occur by subsoiling and seeding where it is practical to do so.

Estimated effects of each action

Table 3 below displays the estimated acres not meeting desired conditions for the soils analysis indicators by treatment activity. Explanation on how these values were reached is described in the Methodology and Analysis Indicators; threshold of concern is 15%. These values would be the same for alternatives 2 through 4 because acres of proposed ground disturbing activities remain the same. Alternative 5 would have less acres of ground disturbing activities. Since results for alternatives 2 through 4 are "worst case scenario" and fall well below threshold, analysis was not run separately for alternative 5. The column described as Acres Not Meeting Desired Conditions are acres for the entire project area.

Table 3: Estimated acres not meeting desired conditions for soil indicators and activity.

Activity		Action
	Estimated Percent Not Meeting Desired Conditions for the North Shore Project, Determined from Disturbance Monitoring on the KNF	**Acres Not Meeting Desired Conditions (Estimated)**
Ground Based Tractor Logging		
Soil Stability	5%	24
Soil Organic Matter	10%	48
Soil Structure	5%	24
Skyline Logging		
Soil Stability	3%	4
Soil Organic Matter	4%	5
Soil Structure	0%	0
Manual Thinning		
Soil Stability	0%	0
Soil Organic Matter	0%	0
Soil Structure	0%	0
Mastication		
Soil Stability	5%	634
Soil Organic Matter	5%	634
Soil Structure	0%	0

Activity		Action
Prescribed Fire		
Soil Stability	0%	0
Soil Organic Matter	0%	0
Soil Structure	0%	0
Re-opened Roads on Existing Roadbeds and Landings		
Soil Stability	5%	3
Soil Organic Matter	100%	48
Soil Structure	100%	48
Total Acres of the Project Area Not Meeting Desired Conditions		
	Soil Stability	665
	Soil Organic Matter	735
	Soil Structure	72
Total Percent Acres of the Project Area Not Meeting Desired Conditions (Forest Plan Threshold is 15%)		
	Soil Stability	1.5%
	Soil Organic Matter	2%
	Soil Structure	0.1%

Compliance with law, regulation, policy, and the Forest Plan

Forest Plan Standards and Guidelines for soils would be met for all proposed activities. The number of acres that do not meet desired conditions for soil stability, soil organic matter, and soil structure does not exceed the threshold of concern within any project area unit or for the total project acreage combined. The acres that would not meet desired conditions following implementation are minor in relation to the project area and well below threshold of concern (15%) as defined in Forest Plan Standards and Guidelines. The number of acres not meeting desired conditions are reduced to the extent possible with project design features.

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Appendix A: Soil Map of the Project Area

Appendix B: Soil Map Unit Characteristics

Summary by Map Unit — Lake County, California (CA033)				
Map unit	**Map unit name**	**Surface Texture**	**Acres**	**Percent**
167	Maymen-Etsel-Mayacama complex, 20 to 60 percent slopes	Gravelly loam	6,537.40	16.40%
170	Maymen-Etsel-Speaker association, 30 to 50 percent slopes	Gravelly loam	1,967.80	4.90%
171	Maymen-Hopland-Etsel association, 15 to 50 percent slopes	Gravelly loam	5,023.70	12.60%
173	Maymen-Hopland-Mayacama association, 20 to 60 percent slopes, MLRA 15	Gravelly loam	933.3	2.30%
174	Maymen-Hopland-Mayacama association, 50 to 75 percent slopes	Gravelly loam	4.6	0.00%
175	Maymen-Millsholm-Bressa complex, 30 to 50 percent slopes	Loam	40.3	0.10%
177	Millsholm-Bressa loams, 30 to 50 percent slopes	Loam	128.2	0.30%
178	Millsholm-Bressa-Hopland association, 30 to 50 percent slopes	Loam	223.6	0.60%

179	Millsholm-Squawrock-Pomo complex, 30 to 50 percent slopes	Loam	33.3	0.10%
183	Neuns-Bamtush-Deadwood association, 30 to 50 percent slopes	Gravelly loam	1,524.50	3.80%
184	Neuns-Deadwood-Bamtush association, 50 to 75 percent slopes	Gravelly loam	887.3	2.20%
185	Neuns-Decy-Sanhedrin complex, 30 to 50 percent slopes	Gravelly loam	226.5	0.60%
186	Neuns-Sanhedrin-Deadwood complex, 30 to 50 percent slopes	Gravelly loam	799	2.00%
187	Neuns-Sanhedrin-Deadwood complex, 50 to 75 percent slopes	Gravelly loam	159.3	0.40%
188	Neuns-Sanhedrin-Speaker gravelly loams, 30 to 50 percent slopes	Gravelly loam	5,292.80	13.30%
189	Neuns-Sheetiron-Deadwood complex, 30 to 50 percent slopes	Gravelly loam	559.9	1.40%
192	Okiota-Henneke complex, 5 to 30 percent slopes	Very gravelly clay loam	36.3	0.10%
193	Okiota-Henneke-Dubakella association, 15 to 50 percent slopes	Very gravelly clay loam	169.3	0.40%
198	Pomo-Bressa loams, 15 to 50 percent slopes	Loam	99.7	0.30%
200	Rock outcrop-Etsel-Snook complex, 50 to 80 percent slopes	Rock Outcrop	724.3	1.80%
201	Sanhedrin-Kekawaka-Speaker complex, 15 to 30 percent slopes	Gravelly loam	86.7	0.20%

202	Sanhedrin-Kekawaka-Speaker complex, 30 to 50 percent slopes	Gravelly loam	1,909.70	4.80%
224	Speaker-Marpa-Sanhedrin gravelly loams, 30 to 50 percent slopes	Gravelly loam	1,169.00	2.90%
225	Speaker-Maymen-Marpa association, 30 to 50 percent slopes	Gravelly loam	699.6	1.80%
226	Speaker-Maymen-Marpa association, 50 to 75 percent slopes	Gravelly loam	11.1	0.00%
229	Speaker-Sanhedrin-Maymen association, 30 to 50 percent slopes	Gravelly loam	2,634.80	6.60%
230	Speaker-Speaker variant-Sanhedrin association, 5 to 30 percent slopes	Gravelly loam	562.4	1.40%
231	Squawrock-Shortyork variant gravelly loams, 15 to 30 percent slopes	Gravelly loam	165.3	0.40%
235	Still-Talmage complex, 2 to 8 percent slopes	Gravelly loam	60.1	0.20%
237	Talmage very gravelly sandy loam	Very gravelly sandy loam	205.9	0.50%
246	Wolfcreek gravelly loam	Gravelly loam	70.6	0.20%
247	Wolfcreek loam	Loam	63.4	0.20%
248	Xerofluvents, very gravelly		26.1	0.10%
249	Xerofluvents-Riverwash complex		321.8	0.80%
254	Yorkville-Yorktree-Squawrock association, 15 to 50 percent slopes	Clay loam	215.4	0.50%

1690	Maymen-Etsel-Snook complex, 30 to 75 percent slopes, low ffd	Gravelly loam	6,247.20	15.70%
Totals for Area:			**39,820.10**	**100.00%**

Appendix C: Soil Map Unit Ratings

Summary by Map Unit — Lake County, California (CA033)							
Map unit symbol	**Map unit name**	**Compaction Risk**	**Current EHR**	**Post Treatment EHR**	**Max EHR**	**Acres**	**Percent**
167	Maymen-Etsel-Mayacama complex, 20 to 60 percent slopes	Moderate	Low	Low	Moderate	6,537.40	16.40%
170	Maymen-Etsel-Speaker association, 30 to 50 percent slopes	Moderate	High	High	Very High	1,967.80	4.90%
171	Maymen-Hopland-Etsel association, 15 to 50 percent slopes	Moderate	High	High	Very High	5,023.70	12.60%
173	Maymen-Hopland-Mayacama association, 20 to 60 percent slopes, MLRA 15	Moderate	Low	Low	Moderate	933.3	2.30%
174	Maymen-Hopland-Mayacama association, 50 to 75 percent slopes	Moderate	High	High	Very High	4.6	0.00%
175	Maymen-Millsholm-Bressa complex, 30 to 50 percent slopes	Moderate	High	High	Very High	40.3	0.10%
177	Millsholm-Bressa loams, 30 to 50 percent slopes	Moderate	High	High	Very High	128.2	0.30%
178	Millsholm-Bressa-Hopland association, 30 to 50 percent slopes	Moderate	High	High	Very High	223.6	0.60%

179	Millsholm-Squawrock-Pomo complex, 30 to 50 percent slopes	Moderate	High	High	Very High	33.3	0.10%
183	Neuns-Bamtush-Deadwood association, 30 to 50 percent slopes	Moderate	High	High	Very High	1,524.50	3.80%
184	Neuns-Deadwood-Bamtush association, 50 to 75 percent slopes	Moderate	High	High	Very High	887.3	2.20%
185	Neuns-Decy-Sanhedrin complex, 30 to 50 percent slopes	Moderate	High	High	Very High	226.5	0.60%
186	Neuns-Sanhedrin-Deadwood complex, 30 to 50 percent slopes	Moderate	High	High	Very High	799	2.00%
187	Neuns-Sanhedrin-Deadwood complex, 50 to 75 percent slopes	Moderate	High	High	Very High	159.3	0.40%
188	Neuns-Sanhedrin-Speaker gravelly loams, 30 to 50 percent slopes	Moderate	High	High	Very High	5,292.80	13.30%
189	Neuns-Sheetiron-Deadwood complex, 30 to 50 percent slopes	Moderate	Low	Low	Low	559.9	1.40%
192	Okiota-Henneke complex, 5 to 30 percent slopes	Moderate	Low	Low	Moderate	36.3	0.10%
193	Okiota-Henneke-Dubakella association, 15 to 50 percent slopes	Moderate	Low	Low	Moderate	169.3	0.40%
198	Pomo-Bressa loams, 15 to 50 percent slopes	Moderate	High	High	Very High	99.7	0.30%
200	Rock outcrop-Etsel-Snook complex, 50 to 80 percent slopes	Rock Outcrop	Not Rated	Not Rated	Not Rated	724.3	1.80%
201	Sanhedrin-Kekawaka-Speaker complex, 15 to 30 percent slopes	Moderate	Low	Low	Moderate	86.7	0.20%
202	Sanhedrin-Kekawaka-Speaker complex, 30 to 50 percent slopes	Moderate	High	High	Very High	1,909.70	4.80%
224	Speaker-Marpa-Sanhedrin gravelly loams, 30 to 50 percent slopes	Moderate	High	High	Very High	1,169.00	2.90%

225	Speaker-Maymen-Marpa association, 30 to 50 percent slopes	Moderate	High	High	Very High	699.6	1.80%
226	Speaker-Maymen-Marpa association, 50 to 75 percent slopes	Moderate	High	High	Very High	11.1	0.00%
229	Speaker-Sanhedrin-Maymen association, 30 to 50 percent slopes	Moderate	High	High	Very High	2,634.80	6.60%
230	Speaker-Speaker variant-Sanhedrin association, 5 to 30 percent slopes	Moderate	Low	Low	Moderate	562.4	1.40%
231	Squawrock-Shortyork variant gravelly loams, 15 to 30 percent slopes	Moderate	Low	Low	Moderate	165.3	0.40%
235	Still-Talmage complex, 2 to 8 percent slopes	Moderate	Low	Low	Low	60.1	0.20%
237	Talmage very gravelly sandy loam	Moderate	Low	Low	Low	205.9	0.50%
246	Wolfcreek gravelly loam	Moderate	Low	Low	Low	70.6	0.20%
247	Wolfcreek loam	Moderate	Low	Low	Low	63.4	0.20%
248	Xerofluvents, very gravelly	Not Rated	Not Rated	Not Rated	Not Rated	26.1	0.10%
249	Xerofluvents-Riverwash complex	Not Rated	Not Rated	Not Rated	Not Rated	321.8	0.80%
254	Yorkville-Yorktree-Squawrock association, 15 to 50 percent slopes	High	High	High	Very High	215.4	0.50%
1690	Maymen-Etsel-Snook complex, 30 to 75 percent slopes, low ffd	Moderate	High	High	Very High	6,247.20	15.70%
Totals for Area:						**39,820.10**	**100.00%**